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Do New Technology-Based Firms Located in Science Parks Really Perform Better? A case of Norwegian Firms.

MSc in Innovation and Entrepreneurship

Isaiah Ouma Omolo

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Abstract

This study aims to understand the role of science parks in the performance of New Technology Based Firms (NTBFs). It focuses on the relations between TMT characteristics and innovation speed with regards to their location (i.e. either in Science Park or Off Science Park).

In an attempt to answer the question, whether NTBFs inside SPs perform better than those outside, I look at the TMT characteristics and innovation speed which previous research have shown to have a positive effect on NTBFs performance. I combine the group, Upper Echelons Theory and the Resource Based Theory to investigate the significance of these parameters in relation to the NTBFs location.

By using a combination of resource based theory (RBT) and upper echelons theory (UET), I developed four hypotheses that compare the outcomes of parameters between those NTBFs based in the SPs and those based outside. The parameters are: TMT performance, TMT polychronicity, TMT diversity and innovation speed. The positive relationship between these parameters and firm performance has been widely supported.

I used mainly quantitative research method to collect the data. However, in order to validate the findings, I did face-to-face interviews. For the quantitative research, my sample consisted of 51 Norwegian NTBFs while for the interviews, I had a sample size of 5 (4 Norwegian NTBFs and Oslo Research Centre).

The findings demonstrate that those NTBFs in science parks exhibit higher TMT performance and TMT polychronicity compared to their counterparts outside the Science Parks. Futhermore, the results shows that TMTs in SPs are less diverse than those outside. However, the innovation speed is not dependent on location of the NTBFs but rather on their industry of operation (i.e. biotech or non-biotech). My empirical material has some implications and directions for further research.

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Chapter 1

Introduction

In recent years, new technology-based firms (NTBFs) have attracted growing interest from both academics and politicians (Almus and Nerlinger 1999). NTBFs are new firms with a high proportion of activities devoted to research and development and are run by entrepreneurs with higher education qualifications (Podoynitsyna, van der Bij et al. 2004). They are basically small firms with a higher inherent innovative potential. NTBFs often spin out from universities or research institutes and cluster around centers of knowledge. NTBFs may also be referred to as High-Tech Start-Ups (HTSUps) or Research based spin-offs (RBSOs).

The main reason for the increased interest is that NTBFs are perceived to play a key role in enhancing entrepreneurship and innovation hence promoting economic growth and offering new employment opportunities (Yang, Motohashi et al. 2009). Drucker (1999) states that entrepreneurial activities are becoming the driving force for innovation while Harris and Trainor (1995) have noted that innovating firms record higher profit margins than non-innovating firms. NTBFs also contribute in strengthening the competitive position of already longer established firms.

Two terms used when describing NTBFs are worth defining: Entrepreneurship and Innovation. Reiss and Cruikshank (2000) defines entrepreneurship as the recognition and pursuit of opportunity without regard to the resources you currently control, with confidence that you can succeed, with the flexibility to change course as necessary, and with the will to rebound from setbacks.

Edelman, Manolova et al. (2008), defines entrepreneurship as the process of creating something new with value by devoting the necessary time and effort, assuming the accompanying financial, psychic, and social risks, and receiving the resulting rewards.

The international association of science parks **(**IASP) defines innovation as "a process, involving multiple activities, performed by multiple actors from one or several organizations,

during which new combinations of means and/or ends, which are new for a creating and/or adopting unit, are developed and/or produced and/or implemented and/or transferred to old and/or new market-partners" (IASP Website).

Van de Ven (1986) defines innovation as the development and implementation of new ideas to solve problems. According to him, "an innovation is a new idea, which may be a recombination of old ideas, a schema that challenges the present order, a formula, or a unique approach which is perceived as new by the individuals involved" (Van de Ven, 1986: 591). This is the definition adopted in this work.

The perception that NTBFs are important in economic growth has led to setting up policies and initiatives mainly by governments, local authorities and higher education institutes (HEIs) aimed at supporting the growth and development of these NTBFs. One such action has been the establishment of science parks (SPs) to promote research based industrial and innovative activity (Löfsten and Lindelöf 2002).

SPs provide the NTBFs with a supportive environment in order to conduct innovative knowledge based activities and thus improve their performance. The performance of NTBFs has also been related to the management team. The studies suggest that a variety of factors related to the composition of the top team may both directly and indirectly impact organizational outcomes such as innovation (Lyon and Ferrier 2002).

Objectives of the Study

Several authors have recorded successful stories about science parks and the benefits they bring to NTBFs located on site (Felsenstein 1994; Lindelöf and Löfsten 2004), while at the same time, some researchers do not agree and doubt the benefits the SPs claim to have to their on-site NTBFs (Westhead 1997; Malairaja and Zawdie 2008). Thus, there exists a mixture of findings regarding the benefits of SPs on the performance of NTBFs. How can these differences be explained? Again, few studies have investigated the link between human resources embodied in the top management team (TMT) and firm performance (Bjørnåli and Erikson 2010).

The main purpose of this thesis is to explore the mixed findings on SP benefits and thus fill this void. It considers and studies several outcomes that could influence the performance of academic spin-offs in Norway. The factors considered are TMT Performance, Diversity, Polychronicity and Innovation Speed with reference to their location i.e. on- or off- Science Park. The work is based on resource-based theory (RBT) and the upper-echelons theory (UET).

The Significance of the Study

This thesis aims at contributing to the theory in two ways: First, by examining the role of top management team (TMT) in academic spin-offs, it contributes to the upper echelons literature. Most available literature have not looked at the TMT in NTBFs (academic spin-off) while considering their location (on- and off SPs). Secondly, it aims to increase insight in the performance of NTBFs based in Norway.

The remaining part of the thesis is structured as follows: Chapter two discusses the literature review while the theoretical background on which this work is based and the hypotheses development is discussed in chapter three. This is followed by the methodology and data collection methods in chapter four. The results of my findings are in chapter five, while chapter six contains the discussions, implications, limitations and further research. The conclusions are in chapter 7.

Chapter 2

Literature Review

2.1 NTBFs and Academic spin-offs

Research based spin-offs (RBSOs), sometimes called university or academic spin-offs are defined as start-up companies/ventures whose formation or creation is dependent on the formal or informal transfer of technology, knowledge or intellectual property rights from the university or public research organizations, and in which the university or the organization holds an equity stake (Wright, Lockett et al. 2006). They can be viewed as sources of employment (Perez Sanchez, Barton et al. 2003) and a cause of economic development (Mian 1997).

NTBFs operate in dynamic and un-analyzable environments. Dynamic because of rapid and continuous changes in the technology and markets they operate on (Yli Renko, Autio et al. 2001). The newness of the technology, its reliability and adoption rate is also unpredictable (Atuahene-Gima and Li 2004). Furthermore, they develop highly differentiated products, in new and often ill-defined segments. The market segments are unpredictable since there are no previous sales data available and as a result difficult to predict buying intentions. Hence establishing a market presence and achieving sustainable returns remains a challenge.

Moreover, since they emanate from the universities, which are historically a non-commercial environment, they may lack commercial resources; hence, may face obstacles and challenges in creating a viable venture. The entrepreneur may also face conflicting objectives from the key stakeholders i.e. the university, the management team and suppliers of finance and as a result, may impact adversely on his/her abilities to develop commercially (Clarysse, Wright et al. 2005).

Most studies (Mustar, Renault et al. 2006) on NTBFs and RBSOs specifically have been generally based on three main theoretical research traditions. These are business model perspective, institutional perspective and the resource based perspective.

Business Model Perspective

These categories of studies are more descriptive in nature (Chiesa and Piccaluga 2000). They mainly describe the activities that are developed and carried out by the NTBFs. They distinguish the sectors in which NTBFs are located and other key indicators that make these companies different from other start-ups, i.e. how they transformed knowledge into value creation. They also focus on sectoral differences, technological regime and product market combinations that generate growth.

Institutional Perspective

The second category focuses on the relation/link that RBSOs have with their parent organization. The parent organization has its own culture, incentive systems, rules and procedures (Moray and Clarysse 2005). These studies are particularly interested in how the institutional context shapes the starting configuration and later development of the RBSO. Most of the studies analyze how decisions or choices (physical location, business model, technological area) made by the parent institute might influence the starting configuration and business model of the RBSO (Westhead and Storey 1995; Steffensen, Rogers et al. 2000).

Resource-Based Perspective

The third category is explicitly or implicitly embedded in the resource-based view (RBV) of the firm (Barney, Wright et al. 2001; Brush, Greene et al. 2001). The studies mainly focus on the resources of the firm as a differentiator and a predictor of competitive advantage. Some authors emphasize the differences in social resources at start-up (Westhead and Storey 1995; Shane and Stuart 2002) as an explanatory factor, while others have focused mainly on the financial resources (Hellman and Puri 2000). Bower (2003) focused on the technological resources while (Heirman and Clarysse 2004) have offered a comprehensive view of different starting configurations that includes social, technological, financial and human resources. The work of this thesis is based on the RBV perspective.

2.2 Science Parks

The concept of SPs originated in the US in the 1950s. The first science park was established in CA, Stanford Industrial Park (currently the Silicon Valley) in the 1950s followed by the Cambridge Science Park, UK, and Sophia Antipolis, France, in the late 1960s. SPs are now widely scattered over the US. In comparison with the US, SPs in Europe have developed slowly (Macdonald 1987).

It was not until the 1980s and 1990s that significant numbers of SPs were established (Storey and Tether 1998). In Norway, the first science park, Oslo Innovation Centre was established in 1984. Currently, there are over 400 SPs in the world and this number continues to grow rapidly due to the governments and other organizations initiatives to provide physical infrastructures for a successful local economy (Löfsten and Lindelöf 2002).

Many terms are used to describe science parks as there is no universally accepted definition of a science park. Several similar terms used are research park, technology park, science centre, business park, research centre, innovation centre, and with various combination of these (Macdonald 1987). However, Research Park is an expression often used in the USA, whereas in Canada, Europe, Asia and Latin America, expressions such as Science Park or Technology Park are preferred.

According to international association of science parks (IASP), a science park is an organization managed by specialized professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. To enable these goals be met, a SP stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with high quality space and facilities (IASP website).

According to the United Kingdom science park association (UKSPA), a SP is a business support initiative whose main aim is to encourage and support the start-up and incubation of innovative, high-growth, technology-based businesses through the provision of: infrastructure and support services including collaborative links with economic development agencies;

formal and operational links with centres of excellence such as universities, higher education institutes and research establishments; management support actively engaged in the transfer of technology and business skills to small and medium-sized enterprises (UKSPA website).

The association of University research parks (AURP) defines a university research park as a property-based venture, which has:

- Existing or planned land and buildings designed primarily for private and public research and development facilities, high technology and science based companies, and support services.
- A contractual and/or formal ownership or operational relationship with one or more universities or other institutions of higher education, and science research.
- A role in promoting research and development by the university in partnership with industry, assisting in the growth of new ventures, and promoting economic development.
- A role in aiding the transfer of technology and business skills between the university and industry tenants (AURP website).

Monck, Porter et al. (1988) defines SPs as property based ventures with clear links to university or other research institutions, where firms can be offered well-suited facilities from which to conduct their business. Siegel, Westhead et al. (2003), define a SP as an area that allows an agglomeration of technological activities leading to positive externality benefits to individual firms located in the park. This is the definition adopted in this work.

2.3 Oslo Innovation Center

Oslo Innovation Centre (***Forskningsparken***) is one of the several SPs in Norway. A list of Norwegian Science Parks is given in appendix 2. It was the first Norwegian science park to be established in 1984 hence the oldest and arguably the largest. It's located in Oslo, the capital city of Norway. Its main shareholders are the University of Oslo, SIVA (The Industrial Development Corporation of Norway, a governmental corporation), and Oslo Municipality among others.

The aim of the Innovation Centre is to provide companies with a rapid means of achieving profitability. It offers researchers/students, entrepreneurs and companies key services which

enable these enterprises to rapidly develop into profitable businesses. Moreover, Oslo Innovation Center is committed to commercialize ideas and results from research environments. Currently, it contains more than 140 companies. Out of these, approximately 55% of the companies have arisen from entrepreneurs from the business community, 25% from researchers establishing their own businesses, and 20% representing the further development of public sector research projects.

The Oslo Innovation Centre has been evaluated by the European BIC Network (EBN) for several years and, in the spring of 2006, was formally approved as an EU-incubator. The focus areas includes and not limited to biotechnology, life science, information and communication technology (ICT), materials research, electronics and energy.

In summary the firms located at the Innovation Centre enjoys the following mentioned benefits and advantages. These could be likewise loosely applied to the other NTBFs based in other SPs in Norway.

a) Academic-Industry Link

The SP has links with University of Oslo, research institutes and the National Hospitals (Aker sykehus, Ullevål sykehus, Rikshospitalet and Radiumhospitalet). This fosters knowledge transfer thus transforming knowledge into innovations resulting into economic growth. As mentioned by Quintas David and Massey (1992), this academic-industry may take many forms such as:

- The transfer of key personnel including founder members of firms to employment in the NTBFs
- The transfer of knowledge through collaborations with researchers and students
- Access to the university facilities
- Contract development, design, analysis, testing, evaluation and many more.

b) Management Function

The start-up process typically involves certain key considerations: developing a business concept, creating a business plan, defining capital needs and securing funds. All these put together could be overwhelming for the entrepreneur and the start ups. Hence the Centre plays

an important role by having close relations with the entrepreneur and is actively involved with extensive pool of resources to complement the entrepreneur and build a winning team thereby develops the most promising research and technology projects into viable start-ups.

In most cases it also includes a formal administrative structure to manage the property on the park and the delivery of activities and professional services required by the firms located on the science parks, with a focus on channeling information and resources to the on-park firms by providing internal networking services between on-park firms and HEIs and external networking services with customers, collaborators and potential investors. They also offer supportive training of the entrepreneur and matching them with people and companies from their network which is vital part for start ups.

Moreover, they help the companies establish contact with national and international customers with the aim of building a sales organization and distribution network which are often critical success factors. The Centre aims to meet the customers' key requirements and facilitates easy access to other quality service providers for specialized needs. Some of the services are provided by the Innovation Centre itself, while others are provided by companies which it owns jointly with others, or by independent entities that operate on their premises.

c) Clustering

Clustering is a term used mostly to refer to spatial co-location involving other organizations that relate to the supply chain of the industry, often including competitors, complementors, suppliers, and customers. Bell (2005) defines cluster as a group of firms from the same or related industries located geographically near to each other.

Chan and Lau (2005) state that high-tech firms of similar characteristics and within the value chain would be attracted to cluster together in the science park and therefore, gradually emerge as a strong allied group complementary to each other. This phenomenon is equally evident in the Oslo Innovation Centre where independent firms that are technology-related and knowledge-based have a degree of geographical proximity thus facilitating information and idea flows through networking which could positively influence the innovative outputs of firms.

Moreover, firms in clusters benefit from network-based effects, especially enhanced social interaction and from the agglomeration economies that result in reduction of operational costs as they develop local and common infrastructure.

d) Knowledge flows

The Oslo Innovation Centre also engages in facilitating the transfer of knowledge and business skills to the organizations on site. Moreover, transmission of knowledge is promoted between firms located in the SPs because of their geographical proximity to each other. Gordon and McCann (2000) confirms that there is maximum flow of information and ideas between proximate firms.

Knowledge transmission can be distinguished into two categories: intended and unintended knowledge flows (Oerlemans and Meeus 2005). Knowledge exchanged with intended people and organizations, is "knowledge transfer", while any knowledge exchanged outside the intended boundary is "knowledge spillover". This could be through reverse engineering or information from patents.

e) Funding

Oslo Innovation Center's incubator facilitates the growth by investing in new and innovative ideas with international potential. The incubator funding consists of a combination of non-diluting funding/grants and equity.

Together with their investment partner Kistefos, Oslo Innovation Center manages a venture fund, Springfondet (seed-fund) that is an early stage investment vehicle taking positions in companies that is past the business incubation. They also have a network of business angels and are experts in attracting public funding enabling the companies to benefit from easy access to both public and private funding.

They partly own, VentureLab which assist with advice in connection with the development and financing of companies in the venture phase. And previously they have contributed to the establishment of the company Biomedisinsk Innovasjon (investor and incubator for start-ups), as a tool to promote project development in the field of biotechnology.

Chapter 3

Theory and Hypotheses

3.1 NTBF Performance

There is limited consensus on how NTBF performance should be measured (Serarols and Urbano 2008). In their research, they categorized the variables into two. The critical/most significant and the secondary. Those regarded as critical for the success of new ventures, are the market and product strategy, the entrepreneur and the industrial structure. At a secondary level of importance, resources, organizational structure, financial aspects and human capital emerge. Again, most of these variables differ in their degree of importance.

On the other hand, some authors (Chandler and Hanks 1993) stress that measuring the success of start-ups is particularly difficult because they lack historical information, generally are not profitable in their first years of operation and tend to lack standardized accounting measures.

In their work, Podoynitsyna, van der Bij et al. (2004), have categorized the diverse variables from the various empirical studies about NTBFs. Their reference model integrates the different perspectives from the existing entrepreneurship and new venture frameworks and consists of four main elements as shown in Figure 1 below. This framework is subsequently used to categorize the various variables reported in empirical studies on NTBF performance.

I base my study on this reference framework and look at the two aspects, the entrepreneurial team and the entrepreneurial resources. This allows me to use the the upper echelons theory (UET) and the resource based theory (RBT) to view the performance of the Norwegian NTBFs with emphasis on their location, either on or off – science parks.

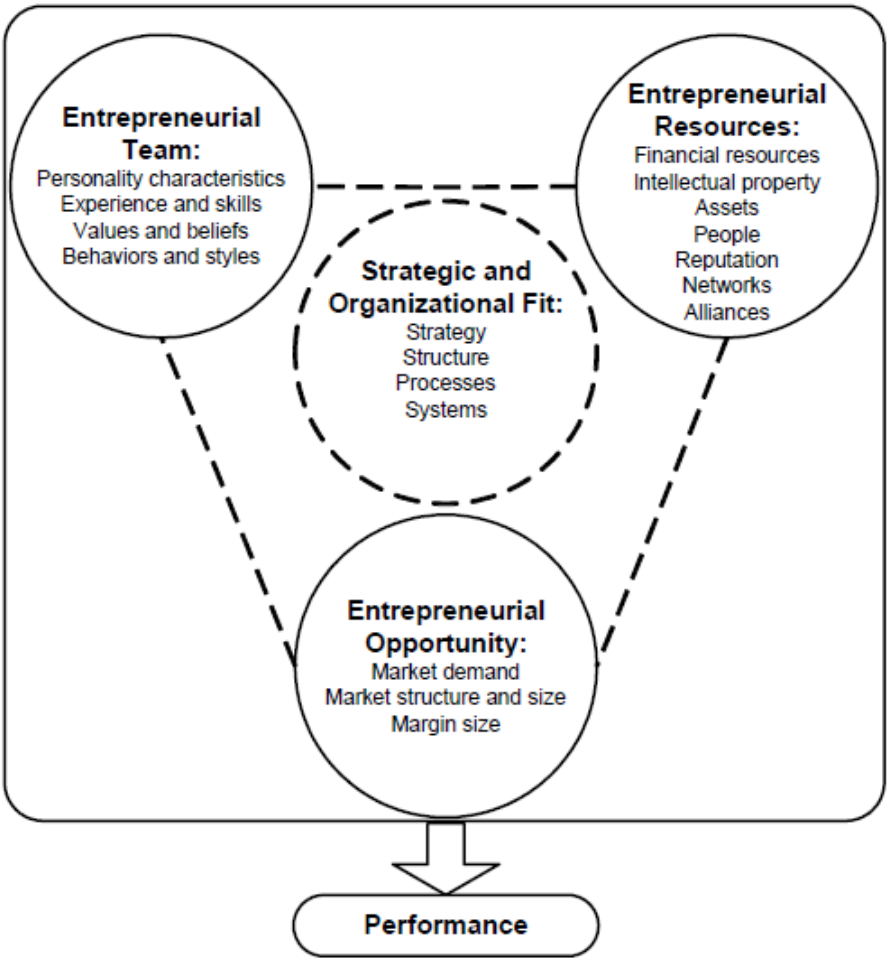

Figure 1: The integrated framework of NTBF performance (Podoynitsyna, van der Bij et al. 2004).

The four main elements are:

- Entrepreneurial Team
- Entrepreneurial Resources
- Entrepreneurial Opportunity
- Strategic and Organizational Fit

The entrepreneurial team has been defined as individuals who jointly establish a firm in which they have a financial interest and a direct influence on the strategic choice of the firm (Gartner, Shaver et al. 1994). Here, researchers have been considered under the following dimensions: personality characteristics; experience and skills; values and beliefs; and behavior and styles (Podoynitsyna, van der Bij et al. 2004).

Entrepreneurial resources include all tangible and intangible assets that a firm may possess and control. These may include among others: financial resources, intellectual property, assets, people, reputation, networks and alliances (Podoynitsyna, van der Bij et al. 2004).

Entrepreneurial opportunities is defined as those situations in which new goods, services, raw materials and organizing methods can be introduced and sold at greater price than their cost of production (Shane and Venkataraman 2000). The quality of opportunity is characterized by such factors as: market demand, structure and size, and margin size.

Strategic and organizational fit refers to the "fit or balance" that emerges from a synergy or interaction between the elements. The components of strategy are: market opportunity, corporate competences and resources, personal values and aspirations and acknowledged obligations to various segments of society. The organization fit results from the dynamic and interrelational between the individuals, environment, organization and process dimensions (Katz and Gartner 1988). The reconciliation of these elements to achieve the balance enhances the performance which depends on congruence of its strategy and structure, processes and systems.

3.2 Theoretical Background

Two complementary theories are used to understand the performance of NTBFs in this work. These are resource-based theory (RBT) and upper echelons theory (UET). These theories share a common emphasis on understanding why some firms can consistently outperform others. Moreover, many authors have intertwined these two theories and I will also draw from both of these topics to develop my theoretical framework around TMT characteristics and NTBF performance in relation to science parks.

Understanding the performance of NTBFs is important as they face various challenges. Firstly, they are characterized by high levels of innovation in new and rapidly changing markets (Ittner, Larcker et al. 2003). Secondly, NTBFs face barriers when trying to attract financing, as the capital providers may not be in a position to evaluate the technology (Wright, Lockett et al. 2006). Lastly, NTBFs face challenges when it comes to human resource and knowledge base (Franklin, Wright et al. 2001). Simply put, NTBFs operate in dynamic and unanalyzable environments.

3.2.1 The Resource Based Theory (RBT)

The resource-based theory, which attributes superior performance to organizational resources and capabilities, has been considered as one of the most influential frameworks in strategic management research (Barney, Wright et al. 2001).

The resource based view (RBV) of firm, also known as the inside-out perspective, has its roots based on a reaction towards Porter's work where it is suggested that a company's strategy should be designed with the market as a starting point (the outside-in perspective).

According to (Porter 1980), the competitive advantage of a firm is based on the five competitive forces: threat of new entrants, bargaining power of buyers, threat of substitute products or services, bargaining power of suppliers and rivalry among existing firms. Here, the competitive advantage of a single firm depends on both the specific industry the firm is in, and the position the firm has in that industry.

However, the RBV school of thought explains that a firm's competitive advantage remains to be found in firm-internal factors, such as resources. Resource-based scholars define resources rather broadly as all tangible and intangible assets semi permanently tied to the firm. As a result, a variety of alternative resource classifications exists.

Grant (1996) classifies resources as: tangible, intangible and personnel-based resources. Tangible resources include the financial capital and the physical assets of the firm such as: plant, equipment and stocks of raw materials. Intangible resources encompass assets such as reputation, brand image and product quality. Finally, personnel-based resources include technical know-how and other knowledge resources including organizational culture, employee training and loyalty, among others.

Brush, Greene et al. (2001) categorized the resources of early stage ventures into six types: technological, human, social, financial, physical and organizational resources. Lichtenstein and Brush (2001) identifies important resources to NTBFs as capital, organizational systems, management know-how, employees, owner's expertise and reputation, technology, physical resources, leadership, organizational structure and culture or informal systems.

Barney (1991) considers firm resources as all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness. He classifies resources as: physical capital, human capital and organizational capital resources.

According to his classification, physical capital resources include the physical technology used in the firm, a firm's plant and equipment, its geography and its access to raw materials. Human capital resources, on the other hand, include the training, experience, judgment, intelligence, relationships, and insights of individual managers and workers in the firm. Finally, organizational capital resources include a firm's formal reporting structure, its formal and informal planning, controlling and coordinating systems, as well as informal relationships among groups within a firm and between a firm and those in its environment.

Barney (1991) argues that in order to hold the potential of delivering a sustainable competitive advantage, a firm resource must possess four attributes:

(i) it must be valuable, in the sense that it exploits opportunities and/or neutralizes threats in a firm's environment,
(ii) it must be rare among a firm's current and potential competition,
(iii) it must be imperfectly imitable, and
(iv) there cannot be strategically equivalent substitutes for this resource that are valuable but neither rare nor imperfectly imitable.

The four indicators have been widely recognised over the years and are called the VRIN variables (valuable, rare, imperfectly imitable, and not substitutable). The link from those resources to a sustainable competitive advantage as seen by Barney (1991) is illustrated in Figure 2 below.

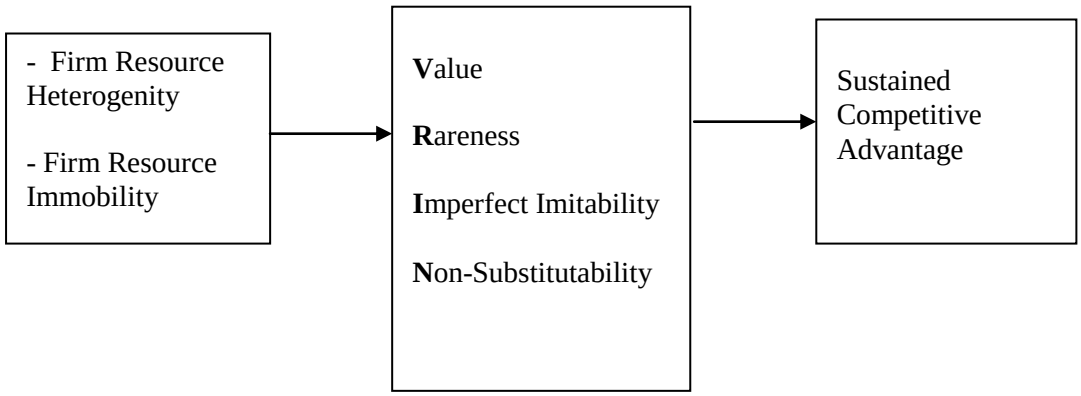

Figure 2: The relationship between resource heterogeneity and immobility, value, rareness, imperfect imitability and non-substitutability and sustained competitive advantage.

Barney (1991) states that a firm is said to have a sustained competitive advantage when it is implementing a value creating strategy not simultaneously being implemented by any current or potential competitors and when these other firms are unable to duplicate the benefits of this strategy. He further distinguishes between competitive advantage and sustained competitive advantage. A competitive advantage vis-à-vis competitors are achieved when a company implements a strategy before competitors and potential competitors, which in turn creates value for the company. However, this competitive advantage is challenged by other companies in the industry and can disappear after a while when other companies manage to duplicate it.

A sustained competitive advantage is only achieved in those cases where other companies fail to duplicate the advantage and cease to try. In such cases the sustained competitive advantage will last until major structural changes in the industry makes the sustained competitive advantage invaluable. Thus, as Barney (1991) also stresses, whether a competitive advantage is sustained or not is independent of the period of time a company enjoys it.

The previous work of Barney (1991) and Brush, Greene et al. (2001) adopts four resource categories: human, social, technological and financial resources. The category '*human resources*' refers to attributes of the founding team, the management team and the personnel of the company. Usually, human resources are measured as: size of the founding team, background and knowledge of the founders, professional management experience and competence, and organizational size.

The management team can be viewed as an internal resource that can give a competitive advantage to a firm and thus be associated with organizational success (Barney, Wright et al. 2001). A firm may develop a sustainable competitive advantage when its management team is made up of people whose resources are valuable, rare, inimitable, non-substitutable and non-transferable.

This unique mix of the human resources drawn from the team could therefore enhance the firm's success and positive performance. Studies have shown that human capital is an important determinant of new venture performance (Cooper, Gimeno-Gascon et al. 1994). Researchers have argued that, in the future, the highest performing entrepreneurial firms will be those with the most outstanding top management teams.

Brush, Greene et al. (2001) define '*social resources*' of a company as its industry and financial contacts. Others refer to these social resources as the network benefits of firms located on or off science parks (Lindelöf and Löfsten 2004). The category '*technological resources*' refers to the firm-specific products and technology (Borch, Huse et al. 1999). Academic spin-offs vary in their scope of their technology, degree of innovativeness and position of the firm in the product-development cycle.

The '*financial resources*' refer usually to the amount and type of financing of the firm. Two types of financing are critical to NTBFs: seed and venture funding. Seed funds are invested in the very early start-up phase while venture capital mainly comes later. Financial and human resources often seem to be the most critical (Moray and Clarysse 2005) and tend to be closely interrelated (Heirman and Clarysse 2004), while the technological resources are usually in place.

3.2.2 Upper Echelons Theory

The relationship between teams and firm performance has been examined in the literature on the "upper-echelon perspective" (Hambrick and Mason 1984). I build on the upper-echelon perspective to analyze the effects of TMT diversity and characteristics on NTBFs performance and in particular academic spin-offs.

The core of the UET is the belief that the organization outcomes are a "reflection" of the characteristics of the TMT (Hambrick and Mason 1984; Finkelstein and Hambrick 1996).

This implies that:

- the actions of the TMT is based on their personalized interpretations of the very situations they face and
- these personalized construal's are a function of the TMTs experience, values and personalities (Hambrick 2007).

A representation of the UET model is represented in the Figure 3 below. From the layout, it's visible that the environmental factors surrounding the firm, upper-echelon characteristics, and the strategic choices made by the top management team (TMT) interact to determine organizational performance levels, i.e. the teams' characteristics influence the interpretation of the external or internal situation and facilitate formulation of appropriate strategic alternatives.

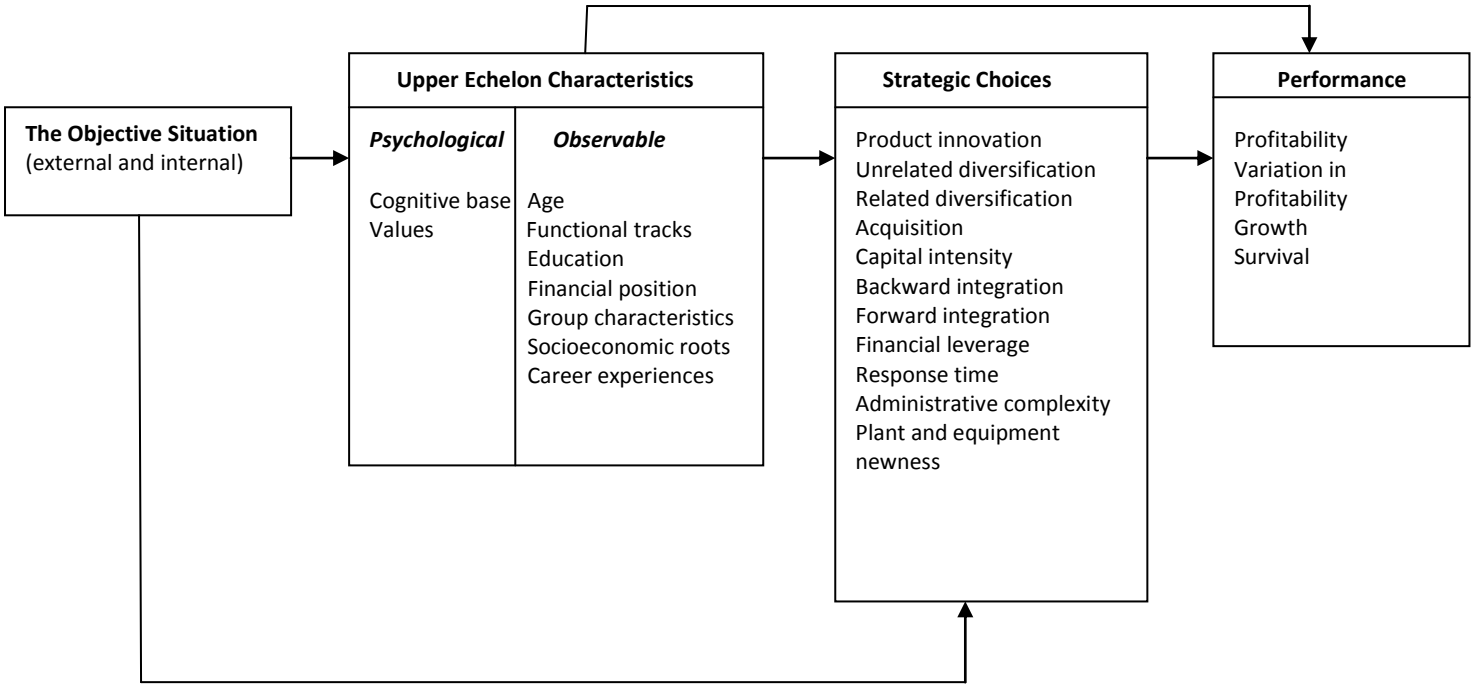

Figure 3: Hambrick and Mason (1984) upper echelons perspective of organizations.

On the left side of the model, are the organization's internal and external situations (within or outside SPs), then the upper echelons characteristics (psychological or observable). However, because of the difficulty in measuring the psychological (cognitions, values and perception), the observable (demographic characteristics) can be used as valid even though these are

argued to be incomplete and imprecise. The characteristics will influence the process of strategic choices that ultimately results in the performance outcome.

In this work, I extend the UET and look at the effects of polychnonicity, a cultural characteristic of TMT on the firm performance. NTBFs have high levels of managerial discretion which implies that TMT characteristics such as polychronicity will strongly influence strategy and hence the performance (Hambrick 2007). TMT also exhibits similarity in their preferences and behavioral tendencies, as they are self-selected groups of people with similar values and beliefs.

3.3 Hypotheses Development

3.3.1 TMT Performance in relation to Location

Team performance refers to the extent to which a team accomplishes its goal or mission (Devine and Philips 2001). Team performance reflects its effectiveness and the overall performance of the firm and thus plays a significant role in facilitating business development and business performance (Ensley, Pearson et al. 2002). Team performance is dichotomized into two broad domains—effectiveness and efficiency. Performance effectiveness is defined as producing precisely the result that was intended, whereas performance efficiency is producing the desired result in an economical manner. This work has looked at performance efficiency.

As mentioned earlier, NTBFs operate in dynamic environments which are very unpredictable. This liability of newness demands that the team must learn to manage a firm that is in itself new while at the same time learning to manage a firm that is also different and unique (Guzzo and Dickson 1996). For the firm to survive, the TMT must overcome these liabilities. This means that the teams must in practice learn to run the new firms, cope with a new environment and deal with new stakeholders while utilizing unfamiliar social networks. Hence, high performing teams that are able to produce innovative solutions and adapt quickly to these changing environments appear to be the main key to NTBF survival and hence increased performance.

Science parks offers business advisory services, seed and/or venture capital, flexibility of premises, administrative facilities and science park management. The effect of cluster also gives an environment for collective learning which enhances performance. Moreover,

empirical studies have revealed a strongly positive association between a firm's performance and its location. Westhead and Storey (1995) surveyed in-science parks and out-science parks firms and found that the probability for a firm to survive in a competitive environment was higher if the firm has a link with a university. Furthermore, the firms that were established in a science park were more likely to have a link with a university. Thus, they argue, the role of the science parks may be proved critical for the survival of small high-tech firms. This leads to the first hypothesis:

Hypothesis 1: NTBFs in SPs will exhibit higher TMT Performance than those outside.

3.3.2 TMT Diversity in relation to Location

One important influence on TMT functioning resides in the composition of the group. Several scholars have highlighted the relationship between venture success and the composition of the entrepreneurial team, defined as the group of people involved in the creation and management of the new venture (Vanaelst, Clarysse et al. 2006).

A large proportion of the upper-echelons studies focus on the homogeneity of the top management team. They argue that to a large extent academic spin-offs have less diverse TMTs and their composition remains homogenous in terms of education, industry experience, functional expertise and skills as the founders mainly select team members from shared network ties and thus lack commercial expertise (Franklin, Wright et al. 2001). Commercial knowledge is of importance for the new ventures especially when it comes to external market trends and situation.

TMT heterogeneity includes the main effects of composition (i.e., educational level) and the demographic dispersion within the TMT (i.e., diversity in tenure, diversity in functional background, age diversity). Diversity is hypothesized to have uniform effects regardless of particular dimensions to which it is empirically applied (Finkelstein and Hambrick 1996).

Beckman, Burton et al. (2007) argue that diversity among team members is usually considered advantageous to the NTBFs and conducive for better performance. Diverse team members are in a position to generate more alternatives while solving a complex problem, hence increase the quality of decision made, which leads to increased team performance

(Cannella, Park et al. 2008). Also, diverse groups have been argued to process different types of information and make better-informed decisions (Hagan, Watson et al. 2007).

Pelled, Eisenhardt et al. (1999) argue that teams with members of different function and work background are likely to have diverse perspectives and expertise which could lead to improved decision making. Heterogeneous teams are viewed as beneficial for strategic change and enhance performance (Bunderson and Sutcliffe 2002). A diverse TMT will search, interpret and gather information from a variety of sources, as determined by their background and cognitive make-up (Wiersema and Bantel 1992; Hagan, Watson et al. 2007).

Functional background has been found to significantly influence TMT's analytical and decision making perspectives (Wiersema and Bantel 1992). TMT's with a broader functional background will be better able to deal with environmental complexities and thus improves the firm's performance. The positive relationship between functional heterogeneity and firm performance has been widely supported in previous new venture studies.

Consequently, other researchers have argued that heterogeneity can lead to less common ground between the team members which may result in conflict (Miller, Burke et al. 1998). Homogeneous TMTs, consisting of members with similar demographical characteristics, have been associated to high group cohesiveness and enhanced control over members (Hambrick and Mason 1984; Finkelstein and Hambrick 1996).

Science park firms may involve in joint research projects with faculty and students; participate in seminars and workshops that provide a forum for the exchange of best practice technical information; recruit university graduates. Moreover, the university links, university education, academics and graduates are a source of diverse skilled manpower which is equally important for the establishment of informal and human relations links.

It's therefore expedient to say that, TMT's with greater diversity of age, tenure, education or functional background may possess a more diverse set of values, experiences and beliefs. I base my arguments and therefore propose that:

Hypothesis 2: NTBFs in SPs will be higher on TMT Diversity than those outside.

3.3.3 TMT Polychronicity in relation to Location

Souitaris and Maestro (2010) defines TMT polychronicity as the extent to which TMT members mutually prefer and tend to engage in multiple tasks simultaneously or intermittently instead of one at a time. They argue that, TMT polychronicity is beneficial for strategic decision making and firm performance.

In more polychronic state, TMT extensively often switch their attention between tasks in responses to new issues or opportunities while in less polychronic state, managers control attention switching and schedules appointments in order to work on a task list sequentially.

Hecht and Allen (2005) while researching on interruptions, mental workload and task switching found out that there is a diminished performance when people switch focus from one task to another or work on several tasks simultaneously. This is confirmed by Jett and George (2003), who argue that intrusions may have negative consequences on a performed task as it may cause delays in its completion or reduce the quality of the outcome. These arguments suggest negative relationship between polychronicity and performance.

However, Souitaris and Maestro (2010), views polychronicity as an attention structure that favours the attendance of unscheduled interpersonal interactions over planned tasks. They suggest that polychronicity helps TMT members to acquire 'insightful' information via unscheduled interactions with other people which affects decision making and firm outcomes. Insightful information here refers to timely, relevant, soft, and privileged information that can change understanding. This standpoint is also echoed by Kotter and Review (1982) who argued that managers work on their tasks in a continuous back-and-forth fashion to encourage the flow of timely information which improves strategic choice and performance.

Because of the leanness of the team, the TMT plays a central role in almost all the activities of the firm. The day to day running of the NTBF (both internal and external) completely and solely relies on them. The entrepreneurs are therefore more likely to multitask resulting in an improvement of the business and may be advantageous to the firm's performance. TMTs could therefore be more or less polychronic depending on their location of operation. As a consequence, I propose as my third hypothesis:

Hypothesis 3: NTBFs in SPs will exhibit a more polychronic TMT behaviour than those outside.

3.3.4 Innovation Speed in relation to Location

Innovation speed has been defined as the time elapsed between initial product development efforts and ultimate commercialization, which is the introduction of a new product into the marketplace (Kessler and Chakrabarti 1996).

Time is typically regarded as something that is constantly ticking away (a scarce resource), and as a consequence TMT must optimize its use (Kessler and Chakrabarti 1996). Since time is a scarce resource, managing it effectively is valuable and an important factor of innovation speed. Moreover, the demand for speed in the workplace is increasing and this has forced a greater percentage of TMT to make decisions faster in the face of frequently changing, high-velocity environments (Vinton 1992).

It has been argued that innovation speed is important to a firm's creating and sustaining competitive advantage amidst rapidly changing business environments (Winter 2003). Speeding up innovation results in costs reduction and increased performance. Lieberman and Montgomery (1988) suggest that speed can facilitate either first-mover or second-mover strategies, depending on which is favored by industry conditions. Being a first mover may confer the advantages of brand loyalty and technological leadership, preemption of scarce assets, and exploitation of buyer switching costs.

Schoonhoven, Eisenhardt et al. (1990) state that the more quickly a new venture develops its first product and ships it to the first customer, the more quickly it will embark the path to greater financial independence, increase its likehood of survival, gain external visibility and legitimacy and thus yielding an early market share. According to Deeds, DeCarolis et al. (2000), the rapid development of new products is a key determinant to success which when combined with core process, can yield significant competitive advantage for a firm.

NTBFs located in SPs benefits from the cluster effects such as inter-firm network and technological/knowledge spill-over from nearby universities and research institutes. This enhanced university partnership could lead to greater utilization of university research results and recourses (library and laboratory facilities) thus stimulate higher research productivity and hence the innovation speed. Again, the positive technological externality can contribute to enhancing the R&D efficiency of these firms. This leads to my fourth hypothesis:

Hypothesis 4: NTBFs in SPs will have a higher Innovation Speed than those outside.

Chapter 4

Methodology and Data Collection

This work adopted mainly the quantitative research method. However, interviews were also done in order to validate the data collected.

4.1 Quantitative Approach

This research applied a quantitative research methodology. The method used was an online survey research powered by CheckMarket. The survey approach is different from other research methods (i.e. case studies or experimental studies) mainly in three ways: First, the collection of information is done by *asking people* in a structured manner either through questionnaires, face-to-face interviews, or telephone calls.

Second, a survey approach is a *quantitative method* that demands standardised information from and/or about the studied subject, e.g. individuals, groups or organisations. Third, information is generally *gathered from a sample*, which is a fraction of a specific population. The sample should be chosen in such a manner that the answers from the sample can be generalised to the whole population (Yin 2009).

4.2 Sample

To fulfil the purpose of this thesis, suitable respondents had to be found. The population, which in literature can be defined as, the entire group of people, firms or plants or things that the researcher wishes to investigate (Forza 2002), were NTBFs mainly academic spin-offs founded in the year 1998 or later, i.e. having their roots from a university or research institute and are in their start up phase.

The initial survey population consisted of 147 NTBFs considered to have originated from Norwegian universities and public research institutes. The companies are registered as having used the university TTO in the FORNY database. FORNY is a government program designed to increase creation of wealth in Norway by supporting the commercialization of R&D results.

E-mails having a link to the online questionnaire were sent to chief executive officers (CEO) inviting them to participate in the study. This choice of CEO was made since it is assumed to be the most knowledgeable informant for the TMT and is likely to have the overall insight of the company (Simons, Pelled et al. 1999). Anonymity of all informants was assured.

A copy of the survey questions used in this study is contained in appendix 1. Most of the items of the questions were based on previous measures proposed in the literature. The firms represents a broad range of sectors such as oil and gas, energy and environment, chemicals and materials, medical and biotechnology, information technology, health, computers, maritime and offshore among others.

4.3 Procedure

An obvious prerequisite for properly carried out survey research is that the respondents must understand and interpret the questionnaire in the same way as the researcher. To make sure this was achieved, the questionnaire was first tested by the research team themselves. From the feedbacks, more opinions were in cooperated into the first draft. Important questions that were initially omitted in the questionnaire were looked into and changes made for readability, i.e. how difficult/easy it was to understand the questions.

A number of steps were taken to increase the response rates to the survey. First, as mentioned, the survey was designed to make it easy to complete. This included laying out the survey clearly, making the questions easy to read and testing out the questionnaire for timing purposes and clarity. Secondly, follow up emails were sent as reminders and telephone calls were made to encourage participants to respond in accordance with the principles outlined by (Dillman 2007).

Out of the 147 emails that were sent, 66 saw the emails. This may be due to the unpredictable nature of NTBFs. Most CEOs do not stay for a long time in the start ups and some of the emails addresses used are institutionally based which are deactivated after a period of time. It could also mean that some of the companies had gone bankrupt or had been dissolved. Out of the 66, 56 firms responded. Four responses were invalid due to the firm characteristics not meeting our criteria for inclusion (selection criteria for NTBFs: firm age less than 13 years, total employees less than 50). Hence after cleaning the data a total of 51 respondents were

used in this study giving an effective response rate of 77%. The response rate would otherwise have been 35%, if I considered all the 147 firms to whom the emails were sent to which is however low.

4.4 Measures

The steps of measure development approach are described in the following section. Identifying the domain of the construct involves describing what is included and excluded from theory.

Most of the independent variables have previously been studied and used in prior research on NTBFs performance. Most of the questions asked to measure the independent variables have also been studied and used in prior research. However the wording of the questions used to explore the variables might have been re-evaluated and modified as necessary to ensure they are precise as possible and suited for this study.

In processing the data, the study used an alpha coefficient (Cronbach 1951) as a proxy for the internal consistency of the scales. The minimally acceptable threshold of an alpha coefficient is $\geq .70$ (Nunnally and Bernstein). The reliability test was done on the variable which had multiple items to determine how well the items measured a single, uni-dimensional latent construct. The results of the reliability analysis indicated that this criterion was met for the scales used.

Factor analysis was also used in the data. This aimed to determine if the items in the variables could be combined into a single scale, since this would simplify the analyses. This was also confirmed by the reliability test. The reliability scales were high enough suggesting that the average sum scores of the items are reliable.

4.4.1 Grouping Variable

As mentioned earlier, the available literature features two contradicting perspectives regarding the performance of firms based on the science parks when compared to those outside. And the grand question becomes: do on-park NTBFs show better performance than those outside? How do the selected TMT characteristics and innovation speed differ from the NTBFs based in SPs and those based outside?

Yang, Motohashi et al. (2009) found out that NTBFs on SPs are more innovative than those outside. Westhead (1997) claimed that science parks can provide a catalytic incubator environment for transforming research into technology development and production. Furthermore, the clustering of NTBFs in science parks is assumed to generate the benefit of inter–firm networks and technological spillover (Pfirrmann 1995). Most studies have also revealed a strongly positive association between a firm's location and its innovativeness (Beaudry and Breschi 2003).

However, some researchers have questioned the assumed benefits of the science park model (Quintas David and Massey 1992; Chan and Lau 2005). In their studies, they found that firms do not gain any benefits from the networking and clustering in the SPs nor from the linkages between the academic research and industrial activity.

In this research, I assume that SPs play a positive role on the performance and as such the location of NTBF is of importance.

4.4.2 Independent Variables

The independent variables are as follows:

a) TMT Performance

High-performing TMTs should lead to high-performing ventures. This is consistent with the upper echelon view that the performance of the TMT is reflected in the performance of the firm itself (Hambrick and Mason 1984).

Team performance refers to the extent to which a team accomplishes its goal (Devine and Philips 2001) and therefore reflects its effectiveness. TMT performance was measured with a scale developed by (Pearce and Sims Jr 2002) and contains three items recorded on a Five-point Likert scale (1 = Very low – 5 = Very high).

The 5-point scales consisted of the following three questions: "Grade the performance of your management team in the light of established performance standards" (1) The amount of work the team produces; (2) The quality of work the team produces; (3) Your overall evaluation of the team's effectiveness. The Cronbach's alpha coefficient for the scale is .82. In this index, a high score indicates a better performance.

b) TMT Diversity

The demographic measures used include both demographic dispersion measures (age diversity, tenure diversity and functional diversity) and direct measures (education level) (Huse 2007). To measure team cognitive diversity, respondents were asked to indicate which category most represented their functional background (engineering, finance, marketing etc). Similar questions were asked with regard to education and industry backgrounds. The Chronbach alpha coefficient is .81.

c) TMT Polychronicity

TMT polychronicity was constructed based on the research by Bluedorn, Kalliath et al. (1999). They have developed and thoroughly validated a scale to measure group polychronicity. Consistent with similar studies (Hecht and Allen 2005), I measured TMT polychronicity by using a concise five-item version of the scale.

The items were measured along a Five-point Likert scale (1 = disagree strongly – 5 = agree strongly). A factor analysis of the scale showed that all five items loaded cleanly on one factor; therefore the construct is unidimensional. However two of the questions were reverse coded.

The 5 items were: (1) We believe people should try to do many things at the same time; (2) We would rather focus on one project each day than on parts of several projects; (3) We tend to juggle several activities at the same time; (4) We think it is best and tend to complete one task before beginning another; (5) We believe it is best for people to be given several tasks and projects to perform simultaneously (Chronbach Alpha .80).

d) Innovation Speed

Previous research on innovation speed has mainly focused on established organizations. Moreover, they have measured innovation speed in the amounts of patents, licensing speed and revenues. However, the use of patents as an indicator of performance presents three major shortcomings: first, not all inventions are patentable. Secondly, most firms prefer to keep innovations secret rather than apply for patents especially if the patents could be a less effective mechanism of appropriating returns. Thirdly, technological opportunities vary

substantially across industries, implying that some firms acquire few patents even though they may essentially devote more efforts to research and development (Cohen et al. 2000).

The measures previously used by other scholars are not applicable here, since my sample is academic spin offs which are still in the stage of product development. In this work, to measure the innovation speed, I asked the firms when the development of the prototype started, and when they had their first sales or expect to have. This follows the method used by Heirman and Clarysse (2007), who measured the innovation time as the number of months between founding and time at which the product was ready for sales. This variable does not require validity check because there is only one construct measuring it.

4.4.3 Control Variables

Consistent with previous TMT studies (Barrick, Bradley et al. 2007), we controlled for firm-level variables (*firm size, firm age*) and TMT demographics (TMT *size, average age, tenure*). These variables have been identified as forces that could influence strategic decision processes and outcomes (Miller, Burke et al. 1998; Hambrick 2007). *Firm size* was measured as the number of full-time employees employed by a firm. *Firm age* was measured as the number of years since the firm's founding. *TMT size* was measured as the number of persons in the management team.

Larger and older firms may have more resources, experience, more information and relationships (Huse 2007). The skills required by a team may vary between younger and older firms (Hambrick and Mason 1984). The size of the top management team may influence the level of heterogeneity found on the team. Large groups, for example, may contain members with more diverse backgrounds.

TMT average age was measured as the mean of the age of all the TMT members. As Hambrick and Mason (1984) note, younger managers may be more oriented toward attempting the novel, the unprecedented and taking risks.

TMT average tenure was measured as the mean number of years of each TMT member as part of the team. Research has found team tenure to be an important antecedent of high performing new venture TMTs (Eisenhardt and Schoonhoven 1990). Increased tenure is associated with stability, reduced conflict and superior communication. In addition, Michel

and Hambrick (1992) suggest that longer tenure on the top management team may be associated with social cohesion and shared cognitive structures. These team attributes may enhance socialization and lead to better firm performance (Carroll and Harrison 1998).

4.5 Data Analysis

The data analysis of the questionnaire was made in SPSS 17. Apart from purely descriptive statistics such as mean values, standard deviation, factor analysis, correlations, discriminant and t – Test analysis were used to compare the two groups (i.e. on and off SP NTBFs).

4.6 Interviews

As mentioned earlier, in order to corroborate the results from the quantitative research, I also conducted interviews. I interviewed TMT of 4 NTBFs and the Oslo Innovation Centre (SP). Two of the NTBFs are based within the Oslo Innovation Centre while two are based outside. Oslo Innovation Centre was convenient as it is both the oldest and centrally placed. Moreover, it has a long-established nature of track record of realizations. As such, it provides an important context to address the research question addressed in this paper.

By so doing, I provide an in-depth exploration of my research objectives and adopt the multi-case, embedded research. The term embedded here refers to the duality of the units of analysis, namely the Science Park and the NTBF. And as Yin (2009) puts it, this may be highly complementary by shedding light on how and why questions and hence offers an understanding as to why the NTBFs located in the SP seems to outperform those located outside the SP.

The NTBFs represents the broad category of area of operation i.e. Energy, IT, Biotechnology and Materials. Data were collected from a variety of sources but primarily using in-depth face-to-face interviews with the CEO (founder) of each of the four companies. Each interview lasted thirty minutes.

Table 1 below provides an insight into the companies that were interviewed. It also gives their founding date, industry of operation, location, number of founders and employees. Apart from these, the management of the Oslo Innovation Centre was also interviewed.

Name of Spin Off	Year of Est.	Industry of Operation	Location	No. of Founders	No. of Employees
NTBF 1	2000	Biotechnology	In SP	2	8
NTBF 2	2001	Materials	In SP	2	4
NTBF 3	2008	IT	Off SP	2	8
NTBF 4	2007	Energy	Off SP	1	7

Table 1: A list of companies that interviews were carried out.

For confidentiality, we replaced the company names by SBEF1 up to SBEF4. SBEF 1 is a vaccine company dedicated to the development of novel vaccines. It is focusing on cancer vaccines and is partnering the technology within infection and veterinary use. SBEF2 develops equipment for electrical and other characterization at high temperatures. Each product is made to meet the special demands of the client.

SBEF 3 does research and development in the area of commercial exploitation of nano- and converging technologies. The main area of interest is Quantum Information Processing and Communication (QIPC). SBEF 4 provides integrated solar heating systems, suitable for a range of applications. It uses polymer materials in the solar thermal applications. Case 5 is The Oslo Innovation Centre, in this case the SP.

Chapter 5

Results

This section contains the results obtained from the survey that was to investigate the effects of SPs on the performance of Norwegian NTBFs while looking as the four mentioned parameters: TMT Performance, TMT Polychronicity, TMT Diversity and Innovation speed.

5.1 Descriptive Statistics and Correlations

Table 2 shows the descriptive statistics and the correlations of the variables used. The average firm age and size are 6.52 years and 8.60 employees respectively showing that they are small firms. This corresponds to the definition of NTBFs (Löfsten and Lindelöf 2002). The TMT size and team members average age are 3.62 and 44.98. The TMT tenure (years of experience) is 10.76 years.

	Mean	**SD**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Location	1.69	.47	1									
2. TMT Av. Age	44.98	9.87	-.128	1								
3TMT Av. Tenure	10.76	7.57	-.097	**.624****	1							
4. TMT Size	3.62	1.46	.215	**-.306***	**-.332***	1						
5. Firm Age	6.52	2.93	.121	**.320***	.076	.059	1					
6. Firm Size	8.60	12.39	.184	-.188	-.029	-.122	-.043	1				
7. Team Perfom.	2.26	0.67	**.425***	-.097	-.020	-.269	-.168	.000	1			
8. Polychronicity	1.94	0.61	**.381***	-.247	-.172	.005	-.064	.058	.008	1		
9. Innov. Spd.	6.14	5.03	-.302	.150	-.236	-.180	.160	.058	**.515****	**-.342***	1	
10. Diversity	0.44	0.13	**.291***	**-.571***	-.304	**.590***	-.050	-.116	-.132	-.064	-.158	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 2: shows the Means, SD and Pearsons correlations among the variables. The correlations give an early insight into the relationships between variables.

The innovation speed represents the development time. It shows the average development time is approximately six years. My measure of innovation speed is in years, from initial development efforts to first product sold on market.

The correlation results indicate a significant and negative relationship between TMT polychronicity and innovation speed. This is an indication that TMT polychronicity has a positive effect on innovation. A negative relationship thus indicates that higher scores of TMT polychronicity will result in less development time.

In addition, the correlation among TMT polychronicity, TMT performance and TMT diversity are statistically significant $p < 0.05$ and in the expected directions. The paths between TMT average tenure and age were also found to be statistically significant $p < 0.01$. However, there is a negative correlation between innovation speed and TMT polychronicity. Innovation speed shows no significant relationship in relation to location, thus indicating no support for my fourth hypothesis. Overall, the correlations listed in Table 2 above support the proposed linkages of parameters in relation to the location.

5.2 Factor Analyses

All the scales in this study were subjected to exploratory factor analysis (principal components analysis using varimax rotation with a criterion of eigenvalue greater than 1.0) to check the validity of the questions measuring Team Performance, Polychronicity and Diversity. The results are of the factor analysis of the variables are recorded in Table 3 below. As seen from the table, the terms factor well and can be measured with a single, unidimensional latent construct.

	Factor 1	Factor 2	Factor 3	Factor 4
Team Performance				
The amount of work the team produces	.865			
The quality of work the team produces	.843			
Your overall evaluation of the team's effectiveness	.864			
Polychronicity				
We believe people should try to do many things at the same time		.863		
We would rather focus on one project each day than on parts of several projects[a]		-.839		
We tend to juggle several activities at the same time		.653		
We think it is best and tend to complete one task before beginning another[a]		-.804		
We believe it is best for people to be given several tasks and projects to perform simultaneously		.847		
Diversity				
Engineering			.929	
Operations			.899	
R&D			.776	
Bachelor			-.715	
Masters[a]			.776	
Finance				.954
Human Resources				.991
Marketing				.883
Ph.D.				.973

[a] these were reverse coded

Table 3: Factor Analysis

5.3 Discriminant Analyses

The results for the discriminant analysis are shown in table 4 below. It shows the overall discriminant model of different independent variable. Since two different statistical approaches are employed in this study, it is important that each criterion variable be clearly specified. For the discriminant analysis, the criterion variable was location of the NTBF either in SP or not.

Tests of Equality of Group Means

	Wilks' Lambda	F	On-Science Parks	Off – Science Parks	Sig.
TMT Performance	.100	18.1	3.87	3.10	.051
TMT Polychronicity	.124	9.2	4.28	3.27	.043
TMT Diversity	.084	21.7	2.69	1.83	.094
Innovation Speed	.462	2.3	2.94	3.17	.266

Table 4: Discriminant analysis *F*-ratios and probability levels for different parameters used to check the NTBFs performance.

The table shows the overall discriminant model of different independent variable. The Wilk's lambda was 4.32 ($p < .05$). The canonical R^2 was .69 ($p < .05$), meaning that the parameters predicted 69% of the variation between those inside SPs and those outside. From the results, it suggests that the on-park NTBFs have higher levels of TMT performance and polychronicity than their off –park based counterparts. However, the TMT diversity is partially supported while the innovation speed is not supported. Generally, it implies that two of the hypotheses are supported ($p < .05$), one is partially supported ($p < .1$) while the fourth one is not.

5.4 t –Test between the Categories

I further investigated the characteristics of NTBFs by looking at the various measures as recorded in table 5. In order to assess the statistical significance of the detected differences, I have run the *t*-tests between the two categories of firms.

	On SP	Off SP
TMT Performance	52.26[a]	29.51[a]
TMT Polychronicity	28.89[a]	13.33[a]
TMT Diversity	17.78	14.33
Innovation Speed	11.04	10.31

[a] Significance level greater than 5%.

Table 5: *t*-Test between the two categories (on- and off-SPs) of NTBFs.

In accordance with the results mentioned earlier, I found no significant difference between on- and off-park firms in relation to their innovation speeds implying it is not influenced by the location on the NTBF. However, TMT performance of on park firms turned out to be of significance at the 5% level: 52% of these firms performed better against 29% of the firms outside the park. In addition, on-park firms TMT are more likely to multitask than those off park (28% against 13%, with the difference being significant at conventional levels). From the results, there is evidence that firms located on SPs are slightly more diverse than those outside: 18% against 14%. Nonetheless, such difference is small and statistically insignificant at conventional levels.

Chapter 6

Discussions, implications, limitations and further research

This section discusses my finding, presents the practical implications of the research and proposes directions of further research. It also addresses the limitations of the study. This study aimed at understanding NTBFs performance with reference to their location by considering the parameters TMT Performance, Polychronicity, Diversity and Innovation Speed. These parameters have been reported to have a positive relationship with the firm performance.

To address my research question, I chose to use the RBV and UET and came up with four hypotheses. From the results, two of the hypotheses, have been supported, one partially supported while the fourth one has not been supported. I used mainly quantitative research methods and my research shows the importance of resources coupled with some TMT characteristics in the performance of NTBFs.

I wish to point out that in the course of this study, they might have been a selection bias. Because SPs systematically look for unique qualities in firms locating to the parks, firms located in the parks may from the onset have their own somewhat unique advantages over their off-park counterparts. This may explain the better performance. Moreover, several advantages are embodied in a firm as a function of its location within the SP.

First, the residential qualification. The NTBFs are reviewed before being accepted into the SP. Generally, they should have a comprehensive plan for product/service development implying they should be involved in R&D leading to innovation. Secondly, the SP based firms enjoy appropriate investment incentives and benefits that reduce their R&D costs and risks. Moreover, they may have access to better human resources and technologies. Thirdly, the clustering effect can reduce transaction costs and enhance performance due to the positive network effects.

Furthermore, the difficulty of getting two very same and equivalent firms cannot be understated. This may not be possible and as such for comparison purposes, I had to overlook the mentioned issues. Having stated this, I now proceed to discuss the results of this thesis.

6.1 Discussions

I will now discuss the findings in reference to my specific hypotheses. **Hypothesis 1** states that *NTBFs in SPs will exhibit higher TMT Performance than those outside.* The results from both the discriminate analysis and the independent t-Test analysis support this hypothesis. In the discriminant function, TMT performance was found to be significant ($p < .05$). The results for correlations coefficients also demonstrate statistically significant support. Both, the cases show that the TMT, values both the amount and quality of work as a measure of performance. Also the overall evaluation of the team's effectiveness was better for firms within the park compared to those without.

Secondly, I expected the TMT within the park to be more diverse than those outside. This form **Hypothesis 2** which states that: *NTBFs in SPs will be higher on TMT Diversity than those outside.* However, from my results, this hypothesis is not fully supported. This implies that contrary to my hypothesis, TMT in SPs are indeed less diverse than their counterparts outside. This is consistent with previous research that have shown that TMTs of academic spinoffs are more homogeneous hence less diverse. On the other hand, prior research have shown (Beckman, Burton et al. 2007) that NTBFs could benefit from teams that are heterogeneous in education, industrial and functional backgrounds. The findings have shown that heterogeneous teams tend to be more effective hence influence positively on team performance. However, as much as the TMTs were researchers with high education level, Masters and PhD and mostly had various backgrounds that were needed for the start ups, they were still less diverse as my results have shown.

Also, the issue of conflicts arising because of diversity cannot be ignored. Ensley and Pearce (2001) differentiates idea and interpersonal conflict. Idea conflict is the level of disagreement that members have about the activities, strategy and goals of the team. Idea conflict can be productive if ideas are openly and respectfully exchanged. Interpersonal conflict occurs when members move their disagreement beyond the scope of the team's purpose. In such instances conflict extends beyond differences of opinion between team members and takes on a more personal nature.

Thirdly, I expected teams in SPs to be more polychronic than those outside. This was the basis of **Hypothesis 3**: *NTBFs in SPs will exhibit a more polychronic TMT behaviour than*

those outside. Based on the assumption of existing literature on polychronicity (Souitaris and Maestro 2010), I expected polychronicity to have a positive effect on the NTBF performance. The results show that TMTs in SPs exhibit high polychronicity than their counterparts outside. Both the correlation coefficients and discriminant analysis shows that the TMT's polychronicity has an influence on the TMT performance and the innovation speed. Polychronicity correlates negatively with the innovation speed, indicating a reduction in development time.

As mentioned earlier, polychronicity enables the TMT to perform several tasks at the same time thus maintaining a wider perspective on tasks and strategies. This enables faster decision making and improves strategic choices and performance. The team based in the park seems to engage in several activities and events at the same time. This might have been that firms within the park had fewer TMT compared to those outside. Polychronicity is thus positively related to strategic decision speed.

Finally, I expected the firms within the SPs to have a higher innovation speed which translates to better performance than their counterparts outside. This addresses **Hypothesis 4**: *NTBFs in SPs will have a higher Innovation Speed than those outside*, thus implying, NTBFs in SPs will have a higher innovation speed than those outside resulting to increase performance. Research has shown a positive influence between innovation speed and successful commercialization and subsequently NTBF success. It shows that those NTBFs that realized great innovation speed were more successful than those who did not generate sufficient innovation speed.

The correlations between innovation speed and team performance shows some significance. However from the discriminant analysis, there is no significance to the NTBF performance in relation to the location hence no support for this hypothesis. This applies same to the independent t-sample tests. Furthermore, there is a negative correlation between diversity and innovation speed. Heterogeneity may reduce the firms speed both in acting and responding because of conflict that may arise due to lack of cohesion (Eisenhardt 1989) and may result in poor performance (Ensley, Pearson et al. 2002).

This implies that the location does not really affect the innovation speed but rather the industry. The non-biotechnology NTBFs have recorded a high innovation speed simple because their products takes less development time compared to the biotech's. Biotechnology

companies face stiff obstacles; many companies stumble on the long and winding road from drug development through regulatory approval to the medical market place. Not mentioning the stages of clinical testing and the FDA approval. Drug development timelines average 7 to 11 years from discovery to launch for pharmaceuticals, while the time frame for biotech firms to bring new medicines to market takes between 4 to 8 years (Powell 1996). Moreover, the process of creating new biotech drugs is research-intensive, very protracted, and extraordinarily expensive.

6.2 Theoretical and Practical Implications

My theoretical contribution lies within the research areas of TMT characteristics and innovation speed in relation to their location. Much of the existing research on NTBF performance has been done in other countries and not in Norway. Again, very few have looked at their performance with regard to their location while applying both the quantitative and the interviews at the same time.

By using the resource-based and upper echelons theory, I have confirmed that TMT is an important resource and an asset to NTBFs. Furthermore, I have shown that TMT performance, polychronicity and diversity are important characteristics of TMT. These characteristics have a direct impact on NTBF performance.

Practically, this research has a number of implications for policy makers, science based entrepreneurs and the academic community. Firstly, it has confirmed to the positive that indeed policy makers who often regard science parks as important drivers of economic regional development because they provide firms with a facilitating environment have not been wrong**.**

To the policy makers and governments, who to a large extent direct their efforts and resources to the establishment of SPs, my research has shown that SPs have an added advantage to the NTBFs. It therefore calls for greater attention from these bodies to initiate and design projects that may promote and support the establishment of SPs. I believe governments have an important role to play especially when it comes to distributing funds for research and infrastructural development.

To the entrepreneurs, it’s shown that the composition of the team is important if they are to perform with great success. Moreover, TMTs who are concerned with performance, should

therefore consider their location. Again TMTs in start up companies have many responsibilities. This demands high standards when it comes to being able to accomplish several tasks at the same time and my findings have found out that polychronicity indeed enhances the performance. The team should therefore aim to be diverse in order to achieve higher performance.

To the academic community, more research should be commercialized and the researchers should be bold enough to launch out and establish spin-offs for they will in most cases succeed. This will increase economic growth and create jobs in return.

6.3 Limitations and Directions for Further Research

As with most studies, this study has a number of limitations that could lead to different directions for further research. First, since this is a study of NTBFs based in Norway, the results of this study cannot be generalized to all other similar cases. More studies could otherwise be done in other comparable countries and contexts to draw a bigger picture that can be generalized.

Secondly, the data collected in this study are cross-sectional and thus not longitudinal. Longitudinal research could shed more light as the NTBFs are young and needs time to grow and develop. Also, the complete innovation process takes time to show results (from idea to prototype to commercializing products).

Thirdly, the sample size of the NTBFs used in the study was 51. A larger sample size could have been more preferable. By increasing the sample size, future research will give more robust and adequate findings which would yield better results and more robust models.

Again, the off-park NTBFs samples were assumed not to have been previously located in the SPs. It could be worth investigating those that were previously resident in the SPs and have since left. Such studies could explore whether the experiences gained while at the SP have an effect in the NTBFs performance. The reasons as to why they left the SPs could also be looked into with the aim to help improve the functioning of SPs.

Since the study is based on NTBFs in different regions, the impact on sectoral differences on NTBFs performance (Kessler and Chakrabarti 1996) cannot be ignored and avoided. This could have been avoided by studying only NTBFs specializing in one particular field.

The study has covered academic spin offs and therefore the findings may not be extended to the performance of non-academic spin-offs. The same applies to non-technology new ventures. Further studies on these should be done in order to strengthen the results and make a solid foundation to theory contribution.

Could geographical locations of the SPs affect the firm performance? How would these results compare with those in other SPs located in other parts on Norway? Again could similar studies done in other parts of the world with different cultures yield similar results? Some studies of other characteristics and performance measures have shown that there is a different preference for strategies and working methods across cultures (Roberts 2001).

Finally, could the performance been due to a selection bias since the NTBFs had promising products before they came into the park. Furthermore, the directions of causality is only argued from a theoretical perspective and I cannot in this study claim directionality.

Chapter 7

Conclusions

The primary purpose of this study was to find out whether NTBFs located in SP really perform better than those located outside the science parks. By using mainly quantitative research method and interviews, while applying the resource based and upper echelons theories, I identified four parameters that could affect the NTBFs performance. I used these to generate four different hypotheses based on existing research supposing that TMT Performance, TMT Diversity, TMT Polychronicity and Innovation Speed are important parameters which may enhance the performance of NTBFs.

For the quantitative research method, all the NTBFs were based in SPs. For the interviews, 2 of the NTBFs were in the SP, while 2 were outside the SP. The results were however not recorded in this work even though they showed consistency with the results from the former.

My results shows that NTBFs based on SPs exhibit higher TMT performance and TMT polychronicity compared to their counterparts outside. It has also shown that contrary to my hypothesis, NTBFs in SPs shows less TMT diversity in comparison to their non-SP based counterparts. However, I found no evidence for the influence of location while considering the effect of innovation speed.

My analysis supports the existing theories on NTBFs performance. It has also bridged the gap between quantitative research methods backed by the interviews approach. Most studies previously done have only applied either qualitative or qualitative, but not both. As such, I have extended prior research hence addresses this gap in literature.

Finally, it has been observed that the science parks offer the added value to firms and as such a resource.

Appendices

Appendix 1: The Questionnaire

* **Team Performance: Grade the performance of your management team in the light of established performance standards:**

	1 Very Low	2	3 Average	4	5 Very High
The amount of work the team produces	☐	☐	◄	►	▲
The quality of work the team produces	☐	☐	◄	►	▲
Your overall evaluation of the team's effectiveness	☐	☐	◄	►	▲

Multitasking

	1 Disagree Strongly	2	3	4	5 Agree Strongly
We believe people should try to do many things at the same tie	☐	☐	◄	►	▲
We would rather focus on one project each day than on part of several projects	☐	☐	◄	►	▲
We tend to juggle several activities at the same time	☐	☐	◄	►	▲
We think it is best and tend to complete one task before beginning another	☐	☐	◄	►	▲
We believe it is best for people to be given several tasks and projectsto perform simultaneously	☐	☐	◄	►	▲

How many members of the top management team fulfill the following functional roles?

Engineering	
Finance	
Human Resources	
Marketig	
Operations	
Research & Development	
Other Functional Roles	

How many of the top management team including yourself have completed following educational degrees?

Bachelor	
Master	
Ph.D.	

About your management team

* **What is your age?**

- 18 - 23
- 24 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 and over

* **What is your gender?**

- Female
- Male

How many years of experience do you have as top leadership team member?

How many members are part of your top management team?

About your Company

What year was the company established?

* **Please indicate the industry the company is operating in:**

* **How many people work full-time for the company?**

* **Is the company located within a university incubator (e.g. technology park, science park, etc.)?**

- Yes
- No

How many patents does the company currently hold or has applied for?

*

Does the company cooperate with direct competitors as business partners (e.g. as suppliers, buyers, subcontractors)?

- Yes
- No

*

In which year did the discovery of your technology (i.e., technological breakthrough) take place?

*

When did the technological development (i.e., development of prototype) start?

*

When did the company have its first sales or expect to sale?

Appendix 2: List of Norwegian Science Parks

Name	**Location**
Bio Park	Ås
Bergen High- Technology Centre	Bergen
Sørlandets Technology Centre	Grimstad
Research Park Lillestrøm	Kjeller
Lillehammer Knowledge Park	Lillehammer
Oslo Research Park	Oslo
Rogaland Science Park	Stavanger
Tromsø Science Park	Tromsø
Trondheim Innovation Centre	Trondheim
Technology Park Grålum	Grålum

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